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# ***JPRS Report***

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# Science & Technology

## USSR: Physics & Mathematics

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[G. A. Mesyats, N. N. Syutkin, et al.; *PISMA V ZHURNAL TEKHNICHESKOY FIZIKI*, 26 Aug 88] ..... 20

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[S. M. Yermakov, A. A. Zhiglyavskiy, et al.; *ZHURNAL VYCHISLITELNOY MATEMATIKI I  
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UDC 539.171.017

**Soviet-American Gallium-Germanium Experiment  
for Registry of Solar Neutrinos**

18620140b Moscow IZVESTIYA AKADEMII NAUK  
SSSR: *SERIYA FIZICHESKAYA* in Russian  
Vol 53 No 2, Feb 89 pp 355-358

[Article by A. I. Abazov, D. N. Abdurashitov, A. V. Avdeyev, O. L. Anosov, Yu. A. Belousko, O. V. Bychuk, Ye. P. Veretenkin, V. M. Vermul, V. N. Gavrin, V. I. Gayevskiy, S. V. Girin, A. M. Grigoryev, S. N. Danshin, L. A. Yeroshkina, V. L. Zhandarov, Yu. I. Zakharov, G. T. Zatsepin, A. V. Kalikhov, S. M. Kireyev, T. V. Knodel, I. I. Knyshenko, V. N. Kornoukhov, S. A. Mizentseva, I. N. Mirmov, Sh. M. Nemstsveridze, A. I. Ostrinskiy, V. V. Petukhov, O. Ye. Pikhulya, A. M. Pshukov, N. Ye. Revzin, R. K. Sedredinov, Ye. D. Slyusareva, M. V. Stepanyuk, A. A. Tikhonov, P. V. Timofeyev, Ye. L. Faizov, A. A. Shikhin, Yu. I. Shilo, V. E. Yants, B. T. Cleveland, J. T. Bowles, S. R. Elliot, H. A. O'Brien, D. L. Vok, J. T. Wilkerson, R. Davis, K. Lande, M. L. Cherry and R. T. Kozes, Nuclear Research Institute, USSR Academy of Sciences, Moscow; Physics Division, Los Alamos National Laboratory, New Mexico; Astronomy and Astrophysics Institute, University of Pennsylvania; Physics Department, Princeton University, New Jersey]

[Abstract] The Soviet-American gallium experiment will be carried out at the Baksan Neutrino Observatory of the

Nuclear Research Institute, USSR Academy of Sciences. The underground laboratory of the gallium-germanium neutrino telescope is situated in a horizontal drift at a distance 3500 m from the surface. The laboratory (volume 7000 m<sup>3</sup>) walls are made of low-background concrete 70 cm thick, covered by a 6-mm steel sheathing. Most of the experimental equipment has already been installed. It includes 10 chemical reactors for the extraction of germanium from metallic gallium and equipment for germanium concentration. The system for operation with 30 tons of gallium is completely ready. It is now being adjusted and filled with gallium. There is a four-channel counting system operating underground. It is proposed that it be expanded to 16 channels. The purification of 30 tons of gallium from germanium, formed by cosmic rays, was completed in the summer of 1988 and the beginning of work on measurement of the neutrino flux from the sun is planned for early 1989. The first results from use of the 30 tons of gallium will become available in 1989. During the course of the experiment the number of operative reactors will be increased to 10 and the quantity of gallium will be increased to 60 tons. Plans call for the entire 60-ton system to be completely operative by late 1989. During 1989 all the necessary apparatus will be prepared for carrying out a calibration experiment with an artificial source of neutrinos (<sup>51</sup>Cr). Unless problems arise, the gallium-germanium neutrino telescope will be calibrated early in 1990. References 20: 7 Russian, 13 Western.

**Subfemtosecond Beats Accompanying Interference by Rayleigh and Four-Photon Scattering Fields**

18620133a Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 49 No 3, 10 Feb 89 (manuscript  
received 12 Dec 88) pp 135-137

[Article by V. L. Bogdanov, A. B. Yevdokimov, G. V. Lukomskiy, and B. D. Faynberg]

[Abstract] Subfemtosecond light beats were discovered accompanying three-wave resonance mixing of ultrashort laser pulses in a dye solution. The experimental scheme is described. Pulses from a R6G laser with combined mode locking were fed to a Michelson interferometer. The design of the latter made it possible to obtain two spatially separated pulses with a small (1 fs/s) rate of change of the time lag  $\tau$  between them. Resonance three-wave mixing signals were observed which were registered by a photodetector. The dependence of signal power on lag time was determined. The subfemtosecond beats were attributable to interference by Rayleigh and four-photon scattering fields. The results are of interest for an analysis of the shape and phase modulation of the pulses because they can provide information supplementing the commonly used interferometer method based on generation of the second harmonic. This is true because the signals are registered with a higher order of interaction than in the interferometer method and an increase in the order of interaction should be accompanied by a strengthening of the dependence of the generated signals on the amplitude-phase characteristics of the pulses. Figures 2; references 4: 2 Russian, 2 Western.

**Formation of Surface Periodic Structures in Recrystallization of Capsulated Islets of Silicon by Laser Radiation of Nanosecond Duration**

18620124a Leningrad PISMA V ZHURNAL  
TEKHNICHESKOY FIZIKI in Russian  
Vol 15 No 1, 12 Jan 89 (manuscript received 2 Nov 88)  
pp 25-28

[Article by A. V. Demchuk and V. A. Labunov, Minsk Radio Engineering Institute]

[Abstract] The formation of a new type of surface periodic structures (SPS) arising during the recrystallization of islets of hypocrySTALLINE silicon (HCS) encapsulated by a silicon nitride layer under the influence of pulsed laser radiation of nanosecond duration is described. The experimental samples were thermally oxidized plates of monocrystalline silicon with a thickness of the SiO<sub>2</sub> layer 0.4  $\mu$ m on which a layer of surface periodic structures 0.33  $\mu$ m was precipitated from the vapor phase at reduced pressure and temperature. The surface of the silicon structures was processed by radiation from an Nd laser with a wavelength 0.53  $\mu$ m. In the range of energy densities 0.6-1 J/cm<sup>2</sup> there was an increase in grain size in the recrystallized HCS layer. With an increase in energy density in the range 1-1.7 J/cm<sup>2</sup> with a width of the HCS islets greater than 10  $\mu$ m

(with a lesser size a degradation of the islets is observed) along the boundaries of the recrystallized islets and the characteristic degradation regions attenuating SPS with a period about 2.5  $\mu$ m, unrelated to radiation wavelength and polarization, are formed. The formation of SPS does not occur with the exfoliation of the encapsulating film. On the basis of these and other findings a mechanism of formation of SPS in the process of formation of HCS islets is proposed. Figure 1; reference: 1 Russian.

UDC 681.7.068:621.373.826

**Locking of SBS Components in Laser With Light Guide Resonator**

18620122a Moscow KVANTOVAYA ELEKTRONIKA  
in Russian Vol 16 No 1, Jan 89 (manuscript received  
22 Sep 88) pp 5-6

[Article by Ye. M. Dianov, S. K. Isayev, L. S. Korniyenko, V. V. Firsov, and Yu. P. Yatsenko, Nuclear Physics Scientific Research Institute, Moscow State University imeni M. V. Lomonosov]

[Abstract] Locking of cascade SBS components excited in a multimode fiber-optic light guide was obtained for the first time. A mechanism is proposed for explaining this operating mode which is based on a new type of intermode wave phase matching. The proposed self-locking mechanism for SBS components requires additional checking, but its relationship to the observed mode of generation of trains of ultrashort pulses is confirmed by the invariability of the speckle structure of radiation in different laser bursts. It is evidence not only of the excitation of some fixed set of light guide modes, but also the phase relations between them. The occurrence of locking in only 60 percent of the bursts may be attributable to random light guide deformations due to external effects. The results suggest good prospects for using the locking of SBS components in multimode fiber-optic light guides, including capillary, for producing ultrashort pulses with ultrahigh repetition rates. Figures 2; references 5: 4 Russian, 1 Western.

UDC 621.373.826.038.824

**Generation of Femtosecond Light Pulses by Laser With Combined Mode Locking With New Saturable Absorbers**

18620122b Moscow KVANTOVAYA ELEKTRONIKA  
in Russian Vol 16 No 1, Jan 89 (manuscript received  
28 Sep 87) pp 32-36

[Article by B. V. Bondarev, V. I. Prokhorenko, G. D. Rodionov, V. B. Sorokin, Yu. L. Slominskiy, and Ye. A. Tikhonov, Physics Institute, Ukrainian Academy of Sciences, Kiev]

[Abstract] The research objective was the shaping of femtosecond light pulses in the entire tuning range (576-615 nm) of the laser dye rhodamine 6G without replacement of the working mixture. A study was made

of the modulating properties of new organic dyes absorbing in the R6G generation range. The research was carried out using a single-stream laser with synchronous pumping from an argon laser with active mode locking. Combined mode locking was studied using the new dyes 3492-y and 3490-y. With the linear single-stream R6G laser the 3490-y dye ensures a stable locking mode over the entire tuning range. Pulse duration varies over the tuning range from 180 to 250 fs with a lasing efficiency up to 17 percent. Both of the new dyes have a high photochemical stability; the parameters of the generated radiation did not change during the course of a month of use of the working mixture. It is believed that the 3490-y dye will also be effective for the purely passive locking of R6G lasers with continuous pumping. Figures 4; references 10: 3 Russian, 7 Western.

UDC 621.373.826:621.7

#### Features of Laser Ignition of Titanium With Slant Incidence of Radiation

18620122c Moscow KVANTOVAYA ELEKTRONIKA  
in Russian Vol 16 No 1, Jan 89 (manuscript received  
5 Nov 87, after revision 6 Apr 88) pp 81-83

[Article by N. A. Kirichenko, Ye. A. Morozova, and A. V. Simakin, General Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Among the factors influencing the efficiency of laser heating an important role is played by the dependence of the absorptivity of matter on polarization and the angle of incidence of radiation on the sample surface. A study was therefore made of the laser heating of samples of an igniting metal having the form of long thin plates by a spatially limited beam of radiation with slant incidence on the surface. The experiment was made using continuous unpolarized radiation of an LTN-103 laser with a power up to 100 W. The titanium samples, 0.5 mm thick, measured 5 x 120 mm. Accuracy in angle measurement was 0.2°. All experiments were made with a constant radius of the radiation beam. The dependence of laser power at the ignition point on the angle of incidence of laser radiation on matter was experimentally studied. The ignition point carries information on the physical processes accompanying the laser heating of igniting metals. The interpretation of this information will make it possible to study the characteristics of ignition and combustion of matter and to optimize laser processing of metals. Figures 3; references: 11 Russian.

UDC 535.211:534.142

#### Pulsed Optoacoustic Effect in Aerosols

18620122d Moscow KVANTOVAYA ELEKTRONIKA  
in Russian Vol 16 No 1, Jan 89 (manuscript received  
17 Mar 88) pp 98-99

[Article by V. P. Zharov, A. Ye. Negin, and Ya. O. Simanovskiy, Moscow Higher Technical School imeni N. E. Bauman]

[Abstract] The optoacoustic effect accompanying the propagation of laser radiation in atmospheric aerosols

was investigated. This effect is described in aqueous aerosols in a broad range of energy densities of radiation of a pulsed CO<sub>2</sub> laser. (A diagram of the experimental apparatus is shown and discussed.) The optoacoustic measurement method using an aerosol flow makes it possible to eliminate the influence of change in the disperse composition of the investigated medium caused by the precipitation of particles on the cell walls. The aerosol was formed by the spraying of water by an air jet. The characteristic size of the aerosol droplets was several micrometers. The acoustic pulse formed with the absorption of laser radiation by aerosol was registered. The experiments were made with a plane flow formed by a nozzle with a section 2 x 30 mm. The plane of flow symmetry intersected the laser beam at an angle 70° and the microphone registering the acoustic pulse was on the normal to the flow plane at a distance 155 mm. The distance from the nozzle section to the center of the laser radiation beam was 17 mm; the beam diameter in the zone of interaction with the aerosol was about 5 mm and the flow velocity at the nozzle section was 0.9 m/s. It was found that there is saturation of an optoacoustic signal with a laser radiation energy density greater than 5 J/cm<sup>2</sup> caused by a change in the disperse composition of the aerosol during the duration of the laser pulse. The described method can be used in investigating the nature of absorption of laser radiation in aerosols and also for monitoring the radiation energy of pulsed lasers. Figures 4; references: 4 Russian.

UDC 621.373.826.038.823

#### KrF-Laser Excited by Powerful Nanosecond Microwave Pulse

18620082a Moscow KVANTOVAYA ELEKTRONIKA  
in Russian Vol 15 No 11, Nov 88 (manuscript received  
14 Jan 88) pp 2331-2333

[Article by V. A. Vaulin, V. N. Slinko, and S. S. Sulakshin, Nuclear Physics Scientific Research Institute, Tomsk Polytechnic Institute imeni S. M. Kirov]

[Abstract] The first results of an experimental study of a KrF-laser with pumping by a nanosecond microwave pulse from a relativistic magnetron generator are presented. (A diagram of the experimental apparatus is presented and discussed.) A lasing efficiency of 4% was obtained with pumping by an excimer laser using a Ne-Kr-F<sub>2</sub> mixture of a nanosecond microwave pulse with a power 200 MW. The microwave energy absorption in the active medium was of an extremal character. The efficiency of the energy input at the maximum was nearly 100%. The mentioned laser parameters are not limiting because the length of the active medium, mixture pressure and optical resonator have not been optimized. Figures 4; references 11: 10 Russian, 1 Western.

UDC 621.373.826

**Dispersion and Spatial Correlation of Laser Beam Intensity in Turbulent Atmosphere With Thermal Self-Stress**

18620082b KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 11, Nov 88 (manuscript received 28 Jul 87) pp 2341-2351

[Article by V. A. Banakh and I. N. Smalikho, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] In a theoretical investigation of the propagation of laser beams in moving randomly inhomogeneous media with thermal self-stress in the heat transfer equation it is customary to use a model of a plane-layered medium, but this model is applicable only for computing mean beam defocusing. In an analysis of fluctuations of the laser radiation field in the heat transfer equation there must be allowance for the dependence of random changes of wind speed on time. A study was therefore made of the dispersion and spatial correlation of laser beam intensity with thermal self-stress in the atmosphere with conservation of the dependence of random wind speed on coordinates and time. The influence of turbulent air mixing and incomplete spatial coherence of the source on the investigated characteristics is analyzed. A nonstationary self-stress effect is considered. It is shown that fluctuations in beam intensity increase and their characteristic spatial scales are increased due to the distortion of radiation on induced temperature inhomogeneities. The conditions under which this occurs are defined. Figures 6; references: 16 Russian.

UDC 535.3:373.826

**Adaptive Focusing of Light Beam by System With Lag in Control Channel**

18620082c Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 11, Nov 88 (manuscript received 15 Dec 87, after revision 24 Feb 88) pp 2379-2381

[Article by V. A. Trofimov, Moscow State University imeni M. V. Lomonosov]

[Abstract] One of the least studied problems in adaptive optics is the focusing of light beams in systems with a lag in the control channel or with a lag in evaluating the state of the medium, although due to the finite rate of operation of elements in any adaptive system a lag is always present during control of beam parameters. Accordingly, on the basis of an aberration-free description of the propagation of a light beam an analysis was made which revealed the distinguishing features of continuous control of beam focusing in a system with a lag. The possibility of the appearance of oscillating and divergent control modes was revealed and the conditions for their appearance are defined. It is concluded that there is an

equivalency of the conditions determining the operational modes of a system with a lag in the case of a continuous control algorithm and a system without a lag when using a discrete control algorithm. References: 7 Russian.

UDC 621.373.826

**Laser Pulse Compression Based on Phase Cross-Modulation Effect in Fiber-Optic Light Guides**

18620100a Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 10, Oct 88 (manuscript received 10 May 88) pp 1941-1943

[Article by Ye. M. Dianov, P. V. Mamyshev, A. M. Prokhorov, and S. V. Chernikov, General Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Methods are proposed for using the phase cross-modulation effect for the spectral broadening of laser pulses and obtaining linear frequency modulation of both positive and negative sign for these pulses. The effect arises with the joint propagation of two (or more) pulses of different frequency in which a nonlinear change in the refractive index induced by one pulse modulates the phase of the other pulse. It is shown that such pulses can be compressed directly in fiber-optic light guides in spectral regions with both negative and positive dispersion of group velocities. By using the phase cross-modulation effect it is possible to achieve a smooth tuning of the laser pulse carrier frequency. Figure 1; references 5: 3 Russian, 2 Western.

UDC 621.373.826.038.823

**CO<sub>2</sub>/SF<sub>6</sub>-Laser With Three-Mirror Resonator**

18620100b Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 10, Oct 88 (manuscript received 27 Jul 87) pp 1955-1958

[Article by V. Yu. Kurochkin, V. N. Petrovskiy, Ye. D. Protsenko, and A. N. Rurukin, Moscow Physical Engineering Institute]

[Abstract] A CO<sub>2</sub>/SF<sub>6</sub>-laser with an internal absorbing cell in which a three-mirror resonator in combination with a telescopic light beam broadener is placed, is described. The experimental apparatus consisted of the single-mode laser and two-section resonator, an auxiliary single-mode CO<sub>2</sub>-laser, an external SF<sub>6</sub> cell and recorder. The first compartment, formed by a diffraction grating and the middle mirror, held a gas-discharge tube. The SF<sub>6</sub> cell was in the second compartment, formed by the middle mirror and an opaque end mirror. The second compartment also held the telescopic broadener, which made it possible to increase the beam diameter to 25 mm. The length of the gas-discharge tube was 50 cm and the length of the absorbing cell was 50 cm with a total length of the resonator 160 cm. The pressure of the absorbing gas was 0.1 Pa. Power resonances with an



amplitude 0.3 mW and a width 100 KHz were produced. The resonance parameters obtained with this laser are not limiting and can be improved with optimization of the resonance parameters and also with two-mode generation. Figures 4; references 11: 7 Russian, 4 Western.

UDC 621.373.826.038.825.2

**Corundum-Titanium Laser With Acoustooptic Tuning of Emission Wavelength**

18620100c Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 10, Oct 88 (manuscript received 3 Feb 88) pp 2009-2010

[Article by Yu. Zh. Isayenko, V. P. Puzikova, L. N. Rayskaya, and Ye. M. Spitsyn]

[Abstract] Corundum-titanium lasers are most efficient with pumping by the second harmonic (532 nm) of a YAG-Nd<sup>3+</sup> laser. An efficiency of about 40 percent was attained in earlier variants. In this article it is shown that emission parameters, including the wavelength of tunable lasers based on solutions of organic dyes, can be controlled by means of an intracavity acoustooptic filter (AOF), considerably superior to mechanical methods. Accordingly, a study was made of tuning of the emission wavelength of a corundum-titanium laser using such an AOF and experimental research on its generation characteristics was carried out. An Al<sub>2</sub>O<sub>3</sub>:Ti<sup>3+</sup> element 3 cm long was used. The optical diagram of such a laser is shown in a figure. A filter of crystalline quartz with quasicollinear interaction was used. The laser with the AOF generated in the range 710-870 nm. The maximal laser efficiency was 8 percent at 800 nm and the width of the generation line was about 0.25 nm. The tuning range and laser efficiency can evidently be increased by using an AOF fabricated from materials with an acoustooptic quality greater than for quartz. Figures 2; references 6: 3 Russian, 3 Western.

UDC 621.391

**Adaptive Restitution of Images of Coherently Illuminated Objects Observable Through Randomly Inhomogeneous Medium Using 'Polarizational' Sharpness Function**

18620100d Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 10, Oct 88 (manuscript received 13 Apr 87, after revision 29 Sep 87) 2093-2099

[Article by A. L. Volpov and Yu. A. Zimin]

[Abstract] A study was made of the adaptive restitution of images of coherently illuminated objects by successive maximizing of the sharpness function by adaptive element cells. It was found that the complex form of this sharpness function does not make it possible to find its absolute maximum and retrieve the object image. A new sharpness function is proposed whose use leads to a minimizing of the integral energy of the field reflected

from the object passing through the analyzer, whose transmissivity is opposite the distribution formed in the picture plane of the object by the illumination sources. The absolute minimum of the "polarizational" sharpness function corresponds to compensation of phase distortions and its successive finding by adaptive element cells is possible in a case when the polarization distribution is formed by two coherent mutually orthogonal polarization sources situated at a short distance from one another. A scheme for practical realization of adaptive image restitution in an optical observation system is proposed. Figures 2; references 8: 6 Russian, 2 Western.

UDC 535:621.373.8

**Effect of Sorption Processes at Surface of Mirror on Optical Properties of Mirror During Laser Action**

18620064b Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 302 No 4, Oct 88 (manuscript received 1 Jul 87) pp 830-833

[Article by S. D. Burakov, A. P. Godlevskiy, and Academician V. Ye. Zuyev, Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] An experimental study of mirrors for laser cavities was made, its purpose being a quantitative determination of changes in their optical properties caused by sorption processes at their surface during laser action. Several multilayer dielectric mirrors produced by stacking alternately seven SiO<sub>2</sub> films and seven TiO<sub>2</sub> films on a substrate of K8 glass were used for building the cavity for a He-Ne laser, such a laser being characterized by a high frequency of relaxation oscillations and high sensitivity to changes in the cavity Q-factor. The mirrors were treated with radiation from a variable-power ruby laser, in pulses of about 0.001 ms duration at a repetition rate of 0.03-0.05 Hz, with normal incidence from the substrate side or at a 70-72 deg angle directly. Both laser beams were precisely aligned and polarized in the same plane. The mirrors were tested after lengthy deaeration, after lengthy contact with water vapor, and in a stream of air with 70 pct humidity. Changes in the emission kinetics of the He-Ne laser served both as measure of changes in the optical properties of the mirrors and as indicator of sorption processes which had taken place during action of the ruby laser. The power of the He-Ne laser was found to consistently decrease after periodically pulsed irradiation of the mirrors by the ruby laser, emission being cut off completely after 50 pulses and not being recoverable till 8-10 h later. From this change of power of the He-Ne laser and the relative excess pump power above its emission threshold were, on the basis of a theoretic relation, calculated the decrements of the reflection coefficient of both cavity mirrors. Figures 2; tables 1; references 4: 2 Russian, 1 Western (1 in Russian translation).



UDC 537.591.8

**Spectrum of Cosmic Ray Muons in Energy Range 10-10<sup>3</sup> TeV and Subsurface Measurement Data**

18620140a Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 53 No 2, Feb 89 pp 342-345

[Article by E. V. Bugayev, Ye. S. Zaslavskaya, V. A. Naumov, and S. I. Sinegovskiy, Nuclear Research Institute, USSR Academy of Sciences; Irkutsk State University]

[Abstract] A number of studies have recently been published giving the results of measurements of the spectrum of muons in the energy range 10-100 TeV: data obtained by two different methods with the Baksan telescope and data obtained by the Krishnaswamy and Moscow State University groups and others. These findings have been compared with one and another and with the results of computations of muon spectra by the phenomenological approach, quark-parton model and quark-gluon strings model. Each of these approaches and the results obtained using them are described. The reasons for the discrepancies appearing with application of the different approaches are examined. For example, it is shown that the predictions based on the quark-gluon strings model fall systematically below the data from the Krishnaswamy and MSU (Baksan) groups. An effort was made to reconcile theory with the mentioned experimental data. Several possibilities are advanced for accomplishing this. Figures 2; references 11: 6 Russian, 5 Western.

UDC 537.591.8

**Possibility of Neutrino Registry Using Extensive Atmospheric Showers Emanating From Earth**

18620140c Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 53 No 2, Feb 89 pp 373-374

[Article by E. Kryz, V. Mikhalyak, A. Vasilevsky, and Ye. Vdovchik, Physics Institute, Lodz University, Polish People's Republic]

[Abstract] The possibility of registry of extensive atmospheric showers (EAS) caused by the interaction of high-energy electron neutrinos in the ground was investigated. The efficiency of detection of EAS emanating from the ground is proportional to the thickness of the ground from which an electron-photon cascade can penetrate into the air. The objective of the study was to obtain quantitative results on the form of the electromagnetic cascade in the ground for energies 10<sup>17</sup>-10<sup>19</sup> eV. In computations by the Monte-Carlo method use was made of precise differential sections for bremsstrahlung and the generation of Migdahl pairs, taking into account the Compton effect,  $\delta$  electrons, ionization and Coulomb scattering. Computations were made for three primary electron energies. Several tables give the values of gamma function parameters and the results obtained using Bethe-Heitler sections in the computations. It was

found that with an increase in primary energy there is a considerable change in the depth of the maximum of the cascade curve and accordingly a decrease in the number of electrons at the cascade maximum. Due to a considerable increase in mean depth and width of the cascade the efficiency of registry in the mentioned range, formed deep in the ground, increases by many times. Figures 2.

**Observation of Weak Charged Current in Interaction of Reactor Antineutrino and Deuteron**

18620133b Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 49 No 3, 10 Feb 89 (manuscript received 26 Dec 88) pp 130-132

[Article by G. S. Vidyakin, V. N. Vyrodov, I. I. Gurevich, Yu. V. Kozlov, V. P. Martemyanov, S. V. Sukhotin, V. G. Tarasenkov, and S. Kh. Khakimov]

[Abstract] The first results of measurement of the interaction sections of reactor antineutrinos and deuterons are given. The studied process can transpire in two channels (neutral current and charged current channels). This article gives an experimental determination of the sections for both channels and describes a search for neutrino oscillations. The "Deyton" ("Deuteron") detector used in the research is an assembly of graphite blocks (neutron moderator and reflector) at whose center is a tank filled with heavy water (99.83 percent pure). The apparatus is penetrated by 151 openings into which 150 proportional neutron counters are inserted. A central opening is for studying the gamma background within the detector. The apparatus registers only neutrons. One neutron is registered in the neutral current channel and two neutrons in the charged current channel. The detector was exposed for 47 days. The results are tabulated (only for the charged current channel) with a comparison of the background and observed effect; the numbers of triple and quadruple events are also indicated. Attempts are being made to reduce the apparatus background and measurements are continuing. Figure 1; references 10: 4 Russian, 6 Western.

**Observation of Stimulated Light Pressure of Amplitude-Modulated Radiation on Atoms**

18620133c Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 49 No 3, 10 Feb 89 (manuscript received 22 Dec 88) pp 138-140

[Article by V. S. Voytsekhovich, M. V. Danilevko, A. M. Negriyko, V. I. Romanenko, and L. P. Yatsenko, Physics Institute, Ukrainian Academy of Sciences]

[Abstract] This report describes the first experimental observation of stimulated light pressure on atoms arising due to the effect of ordering of absorption events and radiation of photons in the field of counter amplitude-modulated waves. The experimental scheme for observation of stimulated light pressure is described. A continuous dye laser operates in a two-frequency generation mode

with a distance 1.67 GHz between these frequencies. A beam of sodium atoms propagates in the resonator perpendicular to the laser. The laser ray diameter is 2 mm. The transverse spatial distribution of beam atoms is registered at a distance 35 cm from the interaction region using a second two-frequency continuous dye laser whose radiation is directed perpendicular to the atomic beam and the ray of the deflecting laser and is focused in a spot measuring about 80  $\mu\text{m}$ . The ray of this laser is scanned perpendicular to the beam; the fluorescence signal is registered using a photomultiplier. In the tuning of the deflecting laser to the region of the D<sub>2</sub> sodium line there is a beam deflection whose magnitude and sign are periodically dependent on the phase difference. The dependence of displacement of the center of mass of the beam profile on intracavity power is close to linear. The observed deflection of the atomic beam in the field of two standing waves with differing frequencies indicates that it is caused by stimulated light pressure. This phenomenon, observed for the first time, may be useful for effective control of the motion of atoms and molecules. Figures 3; references 4: 3 Russian, 1 Western.

#### Fermions on Riemann Surface and Kadomtsev-Petviashvili Equation

18620135a Moscow *TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA* in Russian Vol 78 No 2, Feb 89 (manuscript received 2 Jul 87) pp 234-247

[Article by A. V. Zabrodin, Chemical Physics Institute, USSR Academy of Sciences]

[Abstract] Riemann surfaces correspond to so-called quasiperiodic solutions of the Kadomtsev-Petviashvili equation and other soliton equations, the theory of which is well developed. It was therefore of interest to ascertain the direct relationship between soliton equations and conformal field theories for Riemann surfaces. In this article it is shown that the scattering matrix of free massless fermions on a Riemann surface (determined relative to some choice of asymptotically plane in- and out-regions on the surface) generates quasiperiodic solutions of the Kadomtsev-Petviashvili equation. An operator is constructed which changes the genus of the solution and a composition law of such operators is discussed. This construction is a generalization of the known operator approach in the case of soliton solutions for the general case of quasiperiodic  $\tau$  functions. References 20: 7 Russian, 13 Western.

UDC 539.12

#### New Systems and Conservation Laws for Elastic Wave Equations

18620127 Moscow *DOKLADY AKADEMII NAUK SSSR* in Russian Vol 304 No 2, Jan 89 (manuscript received 28 Oct 87) pp 333-335

[Article by V. I. Fushchich, and A. G. Nikitin, Mathematics Institute, Ukrainian Academy of Sciences, Kiev]

[Abstract] The maximal local group invariance of the fundamental equation for elasticity theory is an eight-parameter Lie group. The question arises as to whether

this fundamental equation has a latent (non-Lie) symmetry which cannot be found in the classical Lie approach. In this article, using methods developed by the author in a series of earlier publications (such as DAN, Vol 246, No 4, pp 846-850, 1979), a positive answer is given to this question. Specifically, a full set of symmetry operators is found for the fundamental equation in a class of second-order differential operators which is considerably broader than in eight-dimensional Lie algebra. New conservation laws for the fundamental equation were written using the determined symmetry operators. The symmetry operators can be used in constructing new coordinate systems in which the variables of the fundamental equation are separated and also for finding precise and approximate solutions of this equation. A non-Lie symmetry of the fundamental equation was discovered earlier by the author, who later gave an explicit form of the integro-differential symmetry operators for this equation in *UKR. MATEM. ZHURN.*, Vol 32, No 2, pp 267-273, 1980. References 7: 5 Russian, 2 Western.

UDC 539.172

#### Nuclear Rainbow Effect and New Parametrization of Scattering Matrix

18620126 Kiev *DOKLADY AKADEMII NAUK UKRAINSKOY SSR: SERIYA A, FIZIKO-MATEMATICHESKIYE I TEKHNIЧЕСKIYE NAUKI* in Russian No 1, Jan 89 (manuscript received 5 Jul 88) pp 65-68

[Article by V. V. Pilipenko, Kharkov Physical Technical Institute, Ukrainian Academy of Sciences]

[Abstract] A new parametrization of the scattering matrix is proposed which within the framework of a simple phenomenological model makes it possible to describe the differential sections of elastic scattering of light ions by atomic nuclei in the energy range greater than 25-30 MeV/nucleon. The results of an analysis of the differential sections of scattering of  $\alpha$ -particles by  $^{40}\text{Ca}$  and  $^{90}\text{Zr}$  nuclei are given for  $E = 141.7$  MeV. The computed sections correctly describe both diffractive oscillations of the angular distributions and the nuclear rainbow effect and are consistent with the experimental data in a wide range of scattering angles. Figures 3; references 6: 1 Russian, 5 Western.

UDC 539.163

#### Intensive Two-Quantum Cascades and New Levels in $^{183}\text{W}$

18620114a Moscow *IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA* Vol 53 No 1, Jan 89 pp 7-12

[Article by S. T. Boneva, E. V. Vasilyeva, Yu. P. Popov, A. M. Sukhovoy, V. A. Khitrov, and Yu. S. Yazvitskiy (deceased), Neutron Physics Laboratory, Joint Nuclear Research Institute]

[Abstract] Study of two-quantum cascades between the compound state of a heavy nucleus and a group of its

low-lying levels affords broad possibilities for investigating both the mean parameters of excited states and  $\gamma$ -decay schemes in a very wide excitation energy range. This article describes measurements made in the beam of the IBR-30 reactor. The capture of thermal neutrons in a  $^{183}\text{W}$  sample was identified by the time-of-flight method. The  $\gamma\gamma$ -coincidences were registered using two Ge(Li) detectors. The measurement and processing methods were described earlier. The spectra of the sums of the amplitudes of the coinciding pulses for  $^{183}\text{W}$  nuclei obtained over the course of about 200 hours are published elsewhere. The threshold of registry of  $\gamma$ -radiation by a single detector was 520 keV. About 150 of the strongest two-quantum cascades were selected for processing. Data on the energy  $E_1$ ,  $E_2$  of successive transitions, the energy of the intermediate level  $E_M$  and the intensity  $i_{\gamma\gamma}$  of the cascades are tabulated, as are other pertinent findings. These results are analyzed and compared and a  $\gamma$ -decay scheme is presented on this basis. References 10: 7 Russian, 3 Western.

UDC 539.141/.142;539.143/.144

#### Experimental Bases for Existence of alpha-Particle Nuclear Matter

18620114b Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 53 No 1, Jan 89 pp 37-47

[Article by S. Ya. Aysina, K. A. Kuterbekov, N. N. Pavlova, and A. V. Yushkov, Nuclear Physics Institute, Kazakh Academy of Sciences]

[Abstract] The cyclotron at the Nuclear Physics Institute, Kazakh Academy of Sciences, was used in carrying out experiments with the scattering of  $\alpha$  particles on light and intermediate nuclei with an energy from 29.3 to 50.5 MeV. The objective of the research was the finding of such experimental methods which would provide direct evidence of the existence (or absence) of intranuclear cluster formation. Two different types of experiments were carried out: experiments based on measurement of nucleus deformation parameters and diffraction experiments. The following subjects are discussed: method for measuring elastic and inelastic nuclear diffraction; method for experimental determination of nuclear deformation parameters and signs; results of search for elastic diffraction anomalies caused by intranuclear cluster formation; laws of change of asphericity of  $4n$ -nuclei as a direct manifestation of a quasicrystalline structure; physical causes of crystallization of  $\alpha$ -particle nuclear matter and detection of local  $\pi$  condensate. It was found that there is a sign-variable change in the asphericity parameter for light nuclei with a mass multiple of four nucleons. Figures 8; references 37: 26 Russian, 11 Western.

UDC 539.17.01

#### Meson Exchange Currents of Second Kind and Neutrino Mass in Processes of $\mu$ -Capture by Light Nuclei

18620114c Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 53 No 1, Jan 89 pp 103-110

[Article by Ch. L. Katkhat, Nuclear Problems Laboratory, Joint Nuclear Research Institute]

[Abstract] An analysis was made of the simultaneous influence of the rest mass of muon neutrinos and currents of the second kind on the asymmetry coefficient of neutrino escape relative to muon spin in processes of capture of polarized muons by light nuclei ( $A, Z$ ). The analysis revealed that in order to obtain a full idea concerning the rest mass of a muon neutrino, the difference of the muon current from a V-A structure and the parameters of currents of the second kind it is necessary to carry out a series of investigations directed to study of the coefficient of asymmetry of the escape of neutrinos relative to the spin orientation of a muon in different transitions with  $\mu$ -capture by light nuclei. In order to solve pressing problems (existence of currents of the second kind and a nonzero neutrino mass) which are in weak interaction with one another it is necessary to have precise measurements of the coefficients of angular and spin-angular correlations in  $\beta$ -decay and  $\mu$ -capture processes. Fig 1; references 30: 13 Russian, 17 Western.

UDC 539.142

#### Relativistic Effects in Kinetic and Potential Energy of Nuclear Nucleons and Internucleon Forces

18620086a Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 52 No 11, Nov 88 pp 2143-2145

[Article by V. A. Krutov, Physics Scientific Research Institute, Leningrad State University]

[Abstract] The reasons for the outstanding success of the relativistic description of residual nuclei advanced by L. D. Miller and A. E. S. Green are examined in detail. Since Miller published his first study it has been assumed that the kinetic energy of nucleons in a relativistic description is approximately 6 MeV per nucleon less than in a nonrelativistic description and precisely this leads to the possibility of a successful description of the nuclear characteristics in the Hartree and Hartree-Fock approximations without allowance for higher orders (correlations). These points are reviewed in detail. It is shown that the relativistic correction to the potential energy of a bound nucleon system is opposite in sign and in value considerably exceeds the relativistic correction to kinetic energy. References 5; 1 Russian, 4 Western.

UDC 539.172.4.162.2+539.122.164

**gamma-Spectroscopy in Filtered Beams of Nuclear Reactor Neutrons**

18620086b Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 52 No 11, Nov 88 pp 2216-2224

[Article by A. V. Murzin]

[Abstract] Sc, Fe-Al-S, Si-S and Sc-Ti filters, making it possible to obtain neutrons with a mean energy  $E_n = 2, 24, 53$  and  $144$  keV, are in use with the nuclear reactor at the Nuclear Research Institute, Ukrainian Academy of Sciences. At a distance  $1$  m from the channel in which the filter is placed the neutron flux output is  $3-6 \times 10^6$  neutrons/cm<sup>2</sup>/s. This article describes the possibility of using filtered beams in the same reactor for investigating the  $\gamma$  spectra from the reaction (ny) in the nuclei  $^{179}\text{Hf}$ ,  $^{191}\text{Ir}$ ,  $^{143,145}\text{Nd}$  and  $^{50}\text{V}$ . In measuring the hard part of the spectrum use was made of a special spectrometer consisting of a Ge(Li)-detector with a volume  $28$  cm<sup>3</sup> and two NaI scintillation detectors. The geometry of the experiment and the characteristics of the filters are described elsewhere. The time for measuring each sample was about  $150$  hours. The results are given separately for each of the mentioned nuclei. These materials demonstrate the possibilities of filtered beams for investigating the spectra of  $\gamma$ -quanta with the capture of neutrons in individual resonances of nuclei of intermediate atomic weight. (This paper was presented at the 37th All-Union Conference on Nuclear Spectroscopy and Atomic Nucleus Structure, Yurmala, April 1987.) Figures 7; references 25: 11 Russian, 14 Western.

UDC UDC 539.165

**Nuclear Matrix Elements of Neutrino-Free Double beta Decay and Neutrino Mass**

18620086c Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 52 No 11, Nov 88 pp 2225-2230

[Article by A. A. Kuliyeu, D. I. Salamov, and S. K. Balayev]

[Abstract] Only the lower limits of the periods of  $2\beta$  decay of a certain number of nuclei are experimentally known. The successes of such experiments have stimulated theoretical research on the nuclear matrix elements entering into decay probability expressions. The already determined limitations on the mass of neutrinos and the constant of proton lepton currents are in disagreement with one another. The principal shortcoming of these studies is that the numerical probability computations have been based on either the phenomenological values of the nuclear matrix elements or they have been computed within the framework of a shell model. In this article it is shown that any precise solution of this problem is dependent to a considerable degree on correct computation of the nuclear matrix elements entering

into the decay probability expression. Numerical computations of the nuclear matrix elements were made on the basis of a superfluid model with allowance for charge-exchange spin interactions between quasiparticles in a random phases approximation. After a full examination of the probability of neutrino-free double  $\beta$  decay, it is shown that for all the considered nuclei theory makes it possible to derive a specific formula for the nuclear matrix elements. Figures 2; references 23: 3 Russian, 20 Western.

UDC 621.373.826

**Formation of Periodic Structures on Surface of Semiconductors Under Influence of Laser Radiation**

18620086d Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 52 No 11, Nov 88 pp 2276-2281

[Article by S. G. Kiyak, A. Yu. Bonchik, V. V. Gafiy-chuk, A. G. Yuzhanin, I. V. Tyslyuk and A. V. Pokhmurskaya, Applied Problems in Mechanics and Mathematics Institute, Ukrainian Academy of Sciences]

[Abstract] The considerable nonequilibrium of processes transpiring in solid bodies under the influence of laser radiation can lead to the appearance of new physical phenomena not arising under equilibrium conditions. These are self-organization processes manifested in systems which have lost their thermodynamic equilibrium. In electron hole plasma generated by laser radiation there can be a spontaneous stratification of the uniform temperature state of the crystal lattice and a concentration of current carriers. This phenomenon was investigated in an examination of the effect exerted on semiconductors by pulsed laser radiation (pulses  $10^{-4}$  s) with light flux power densities less than  $10^5$  W x cm<sup>-2</sup>. It was found that nonuniform temperature fields arising during laser radiation heating determine the specifics of fusion of materials in the initial stage of the process. The experiments were made using samples of dislocation-free silicon oriented in the planes (100) and (111) and measuring  $5 \times 5 \times 0.3$  mm and platelets obtained by cleavage of crystals in a vacuum. Two types of lasers were used for irradiation of the samples. Regardless of laser wavelength, in the initial stage fusion has a local character. This is true when special measures are not taken for smoothing out the temperature fields. These spots acquire (due to the thermal stresses intensifying the anisotropy of thermophysical properties of surface layers) the form of squares on the (100) plane and triangles on the (111) plane. Under the influence of millisecond pulses of an Nd laser ( $\gamma = 1.06$   $\mu\text{m}$ ) the mean period between the local melt spots decreases due to the high rates of heating and high absorption coefficient values. Figures 2; references 18: 3 Russian, 15 Western.

UDC 535.371:541.127

**Method for Determining Rate Constants of Elementary Processes in Atoms and Molecules**

18620095a Tomsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: FIZIKA in Russian Vol 31 No 10, Oct 88 (manuscript received 2 Feb 87) pp 19-23

[Article by V. V. Stenina and O. V. Ravodina, Siberian Physical Technical Institute imeni V. D. Kuznetsov, Tomsk State University]

[Abstract] A variant of a method for determining the rate constants of elementary processes transpiring in plasma, including the irradiation of plasma by resonance radiation, is proposed. In the proposed variant the irradiation power changes in the experiment but remains less than the value which ensures fluorescence saturation. It is shown that this method makes it possible to determine several constants simultaneously. The method is illustrated for the  $C_2$  molecule. The effective section of thermal excitation of the level  $d^3\Pi_g$  from the states  $(X^1\Sigma_g^+ + a^3\Pi_u)$ , equal to  $3 \times 10^{-18} \text{ cm}^2$  plus or minus 80 percent, is determined. It is thereby demonstrated that the experimental dependence of laser-induced fluorescence of plasma on the intensity of laser radiation makes it possible to compute the characteristics of elementary processes transpiring in plasma. Figures 2; references 8: 4 Russian, 4 Western.

UDC 539.172.3

**Polarizations of Particles in Decays of  $^5\text{He}_{\text{Lambda}}$  and  $^4\text{H}_{\text{Lambda}}$  Hypernuclei**

18620095b Tomsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: FIZIKA in Russian Vol 31 No 10, Oct 88 (manuscript received 25 Mar 86) pp 100-103

[Article by V. A. Lyulka, Atomic Energy Institute imeni I. V. Kurchatov]

[Abstract] Research was carried out on the polarizations of nucleons in decays of hypernuclei  $^5\text{He}_{\Lambda} \rightarrow ^4\text{He} + p + \pi^-$ ,  $^4\text{H}_{\Lambda} \rightarrow ^3\text{H} + p + \pi^-$  and  $^4\text{H}_{\Lambda} \rightarrow ^3\text{He} + n + \pi^-$ . Allowance was made for the effect of strong interaction in the final state. A considerable role of resonance interaction in the system  $p - ^4\text{He}$  in the formation of proton polarization in  $^5\text{He}_{\Lambda}$  decay is predicted. It is also shown that in the decay  $^4\text{H}_{\Lambda} \rightarrow ^3\text{H} + p + \pi^-$  the polarization components for protons must attain considerable values, whereas in the charge-exchange decay  $^4\text{H}_{\Lambda} \rightarrow ^3\text{He} + n + \pi^-$  the polarization of neutrons is small. Figures 2; references 11: 5 Russian, 6 Western.

**Muons From Cosmic High-Energy Photinos**

18620101a Moscow YADERNAYA FIZIKA in Russian Vol 48 No 4 (10), Oct 88 (manuscript received 18 Dec 87) pp 1011-1022

[Article by V. S. Berezinskiy, E. V. Bugayev, and Ye. S. Zaslavskiy, Nuclear Research Institute, USSR Academy of Sciences]

[Abstract] A space source, constituting a compact "accelerator" of protons (nuclei) and a gaseous (or dense) target, may generate photinos as well as photons and neutrinos. A study was made of the generation of muons in photino-nucleon scattering at high photino energies (greater than  $10^4 \text{ GeV}$ ). It is shown that muons are generated due to production and subsequent decay of charmed hadrons. The quark subprocess involved is examined. It was found that muons are generated by photinos less effectively than by neutrinos. On the other hand, the  $\gamma N$  cross section at superhigh energies is two orders of magnitude greater than the  $\nu N$  cross section. This is a definite signature of a photino produced by a source in combined observations by means of extensive atmospheric shower apparatus and deep underwater detectors: there is an intensive extensive atmospheric shower flux when there is a small flux of underground high-energy muons. Figures 4; references 26: 8 Russian, 18 Western.

**Search for New Physics in Decays  $\pi^0 \rightarrow \gamma + \text{"Nothing"}$**

18620101b Moscow YADERNAYA FIZIKA in Russian Vol 48 No 4 (10), Oct 88 (manuscript received 11 Dec 87) pp 1075-1083

[Article by M. I. Dobrolyubov and A. Yu. Ignatyev, Nuclear Research Institute, USSR Academy of Sciences]

[Abstract] Search for the decay  $\pi^0 \rightarrow \gamma + \text{"nothing"}$  is an extremely effective method for investigating the properties of new light-gauge bosons predicted in a number of modern models (by "nothing" is meant neutral particles slightly interacting with matter, not registered by a detector). A characteristic feature of experiments for seeking processes of the type  $\pi^0 \rightarrow \text{"nothing"}$  is uncertainty in the interpretation of a positive result because various hypothetical particles may be represented by the "nothing." In this article it is demonstrated that radiational decay  $\pi^0 \rightarrow \gamma + \text{"nothing"}$  is substantially different in this respect. By detecting this it could be confirmed that precisely a new vector boson has been found, not something else. A negative result of such an experiment would impose new restrictions on the properties of the hypothetical light-gauge boson. In Section 2 an estimate of the contribution of scalar particles to this decay is presented. Section 3 gives an estimate of the contribution of spinor particles. Section 4 analyzes the probability of generation of a vector boson. General conclusions are formulated in Section 5. Figures 2; references 16: 4 Russian, 12 Western.



UDC 539.3

**Transforms of Green's Tensors and Boundary Potentials in Dynamic Problem of Elasticity Theory for Half-Space**

18620110 Alma-Ata IZVESTIYA AKADEMII NAUK KAZAKHSKOY SSR: SERIYA FIZIKO-MATEMATICHESKAYA in Russian  
No 5 (144), Sep-Oct 88 (manuscript received 16 May 88)  
pp 67-71

[Article by Sh. M. Aytaliyev and Sh. A. Dildabayev, Mathematics and Mechanics Institute, Kazakh Academy of Sciences, Alma-Ata]

[Abstract] Boundary integral equations for an elastic half-plane with an opening with dynamic loads on its contour were written by L. A. Alekseyev (IZV. AN KazSSR. SER. FIZ.-MAT., No 3, pp 37-52, 1987). Proceeding on this basis, the article examines the problems involved in constructing Green's tensors for a half-space in the case of the first and second boundary value problems. Boundary potentials are introduced for a simple and double layer, on the basis of which boundary integral equations are derived for a half-space. References: 3 Russian.

**Electromagnetic Radiation of Surface Solitons**

18620044a Leningrad PISMA V ZHURNAL  
TEKHNICHESKOY FIZIKI in Russian  
Vol 14 No 14, 26 Jul 88 (manuscript received  
21 Jan 88) pp 1264-1268

[Article by G. I. Zaginaylov, Kharkov State University  
imeni A. M. Gorkiy]

[Abstract] The possibility of surface electromagnetic solitons being radiated in a semiconfined electron plasma is examined theoretically, existence of such solitons in a fully confined plasma having already been indicated by various other authors. This possibility is established on the basis of Maxwell field equations for a quasi-potential surface wave in a plasma half-space, disregarding the nonlinear plasma current and the nonlinear components of the radiation field. The general solution is obtained in a manner analogous to that for an unbounded plasma and with the appropriate boundary conditions then taken into account. The author thanks A. N. Kondratenko and V. M. Kuklin for interest and helpful discussions. Figures 1; references 7: 6 Russian, 1 Western.



**Noise Discrimination During Propagation of Quasisoliton Pulse in Single-Mode Fiber-Optic Light Guide**

18620133d Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 49 No 3, 10 Feb 89 (manuscript  
received 29 Dec 88) pp 141-143

[Article by Ye. M. Dianov, D. V. Korobkin and A. M. Streltsov, General Physics Institute, USSR Academy of Sciences]

[Abstract] One of the methods for generation of ultrashort light pulses of femtosecond duration is the use of a cascade process of induced Raman scattering in a single-mode fiber-optic light guide with the simultaneous transpiring of modulation instability effects. No exhaustive study of this process has been made and it is unknown whether the shaped pulses in actuality are solitons or whether their stationarity is caused by the pumping of energy due to induced Raman scattering from the region of shorter wavelengths. In an earlier study all the radiation from the light guide in which a short pulse was formed was introduced into the same fiber, leaving many ambiguities. In addition, there have been few experiments for studying the dynamics of perturbations of the soliton + noise type. The objective of this research was a study of the dynamics of a quasisoliton with noise in the absence of pumping (case of a conservative system). The experimental apparatus is described elsewhere. The research indicated that under the joint influence of the induced Raman scattering and modulation instability effects soliton pulses are formed and due to dispersion effects the noise component can be eliminated. Figures 2; references 5: 3 Russian, 2 Western.

**New Mechanism for Generation of Second Optical Harmonic With Reflection From Surface of Nonuniformly Deformed Centrosymmetric Semiconductor**

18620120b Leningrad ZHURNAL TEKHNIЧЕСКОY  
FIZIKI in Russian Vol 59 No 1, Jan 89 (manuscript  
received 20 Oct 87) pp 98-106

[Article by S. V. Govorkov, V. I. Yemelyanov, N. I. Koroteyev, G. I. Petrov, I. L. Shumay, and V. V. Yakovlev, Physics Faculty, Moscow State University imeni M. V. Lomonosov]

[Abstract] For the first time a study was made of the possibility of generation of an anomalously strong second harmonic during reflection from the surface of centrosymmetric crystals subjected to nonuniform deformation. A theory is developed for quadratic susceptibility caused by deformation on the basis of a model of molecular  $SP^3$  orbitals. A multiple (by a factor greater than 100) signal increase was experimentally observed, as well as a change in the orientation dependence of the second harmonic with reflection from centrosymmetric crystals in whose surface layer there are inhomogeneous

deformations caused either by a nonuniform distribution of defects associated with ion implantation (after annealing) or by mechanical stresses at the interface between a crystal and different films applied to its surface. The experimental results are consistent with theoretical estimates and can be used in determining the nature of change of deformation with depth. Figures 3; references 17: 8 Russian, 9 Western.

**Synchrotron Maser Based on Free Electrons**

18620120c Leningrad ZHURNAL TEKHNIЧЕСКОY  
FIZIKI in Russian Vol 59, No 1, Jan 89 (manuscript  
received 3 Nov 87) pp 180-184

[Article by D. I. Kalchev and E. A. Perelshteyn]

[Abstract] In a synchrotron maser proposed in an earlier study the induced synchrotron radiation is formed with the rotation of a linear electron beam in a magnetic field within a two-mirror resonator. For the generation of short-wave electromagnetic radiation it is necessary to have highly precise beams with a high electron energy (the wavelength of the induced radiation must correspond to the maximal spectral intensity of spontaneous radiation). However, many aspects of a synchrotron maser based on free electrons have remained unclear. This article gives an analysis of induced synchrotron radiation of relativistic electron rings by which it is possible to increase electron energy due to betatron acceleration in charged particle accelerators. It is shown that with a changeover from linear beams to rings it is possible to expect an increase in the efficiency of radiation generation due to multiple passage of electrons through the resonator. Figures 4; references: 3 Russian.

UDC 530.145.1

**Content of Pauli Principle for Precise Wave Functions**

18620132 Moscow DOKLADY AKADEMII NAUK  
SSSR in Russian Vol 304 No 3, Jan 89 (manuscript  
received 4 Nov 87) pp 595-598

[Article by Ye. A. Smolenskiy]

[Abstract] A new approach is proposed for finding solutions of the stationary Schrodinger equations for many-electron systems by constructing nodal surfaces in configuration space. The finding of virtually precise wave functions for many-electron systems could be of fundamental importance for the quantum mechanics of atoms and molecules and also for quantum chemistry. However, the finding of functions comparable in accuracy to the Hilleraas and James-Coolidge functions for many-electron systems involves very great mathematical difficulties when making the required computations. The limited interpretation of the Pauli exclusion principle plays an important role because it is precisely the need for antisymmetrization which gives rise to most of the difficulties. In earlier studies by the author (DAN, Vol 266, No 1, p 160, 1982; TEKh, Vol 19, No 5, p 523,

1983) it was proposed that the antisymmetrization requirement be replaced by a system of boundary conditions for some surfaces in configuration space. However, the problem then arises of constructing these surfaces. This article gives a solution of this problem. Figures 2; references 6: 3 Russian, 3 Western.

UDC 621.396.22.029.7

**Stabilization of Degree of Compression of Randomly Modulated Multisoliton Pulses by Cascade Spectral Filtering Method**

18620122e Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 16 No 1, Jan 89 (manuscript received 16 Mar 88) pp 130-133

[Article by V. A. Vysloukh and N. A. Sukhotskova, Moscow State University imeni M. V. Lomonosov]

[Abstract] A study was made of the competition of automodulation instability phenomena in multisoliton pulses relative to small stochastic perturbations of amplitude and phase and self-compression in fiber-optic light guides. A numerical analysis was made of the dynamics of randomly modulated N-soliton pulses. For pulses with an initial duration of tens of picoseconds automodulation instability may be the principal physical mechanism restricting the limiting degree of self-compression. A model was constructed of the compression of randomly modulated multisoliton pulses in which a nonlinear medium (optical fiber) is broken down into fragments and the spectral filtering of radiation is accomplished by beam diaphragming. The research revealed the possibility of suppressing automodulation instability and a considerable stabilization of the length and degree of self-compression of multisoliton pulses in fiber-optic light guides, whose amplitude and phase are randomly modulated at the input by the cascade spectral filtering method. The efficiency of the proposed compression scheme increases if energy fluctuations of pulses are first stabilized at the 3-5% level. Figures 3; references 8: 5 Russian, 3 Western.

UDC 534.222.2:553.81:54-114

**Synthesis of Diamond Accompanying Dynamic Loading of Organic Substances**

18620134b Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 303 No 3, Nov 88 (manuscript received 20 Jul 88) pp 625-627

[Article by V. F. Anisichkin, I. Yu. Malkov, and V. M. Titov, corresponding member USSR Academy of Sciences, Hydrodynamics Institute imeni M. A. Lavrentyev, Siberian Department, USSR Academy of Sciences, Novosibirsk]

[Abstract] Organic substances were added to charges of bulk explosive in order to provide the necessary conditions for the synthesis of diamond. After expansion of

the detonation products their condensed phase was subjected to chemical and X-ray structural analysis. In some experiments for increasing the pressure and temperature the mixtures of investigated substances and explosives were encased in shells of more powerful explosive. Studies were made of sugar, benzene, ethanol, glycerin, benzene, acetone, paraffin, hexane and other substances. A table gives the relative yield of diamond phase for different organic substances. It was found that the formation of the diamond phase is universal for all organic substances in the process of destruction of their molecular structure when the presence of free carbon and adequately strong dynamic loading are ensured. However, despite a comparable total yield of the condensed form of carbon, which is determined for the most part by the balance of carbon participating in the transformations, the yield of the diamond phase differs substantially for different substances and is dependent on the individual properties of the investigated compounds. With an adequately great shock wave intensity the total destruction of organic substances and the yield of diamond become nondependent on the initial molecular structure. Figure 1; references 12: 9 Russian, 3 Western.

UDC 535.9

**Formation of Nondissipative Shock Wave**

18620052 Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 301 No 4, Aug 88 (manuscript received 22 Apr 87) pp 851-854

[Article by A. V. Gurevich, corresponding member, USSR Academy of Sciences, Institute of Physics imeni P. N. Lebedev, and A. L. Krylov, Institute of Geophysics imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow]

[Abstract] Formation of a nondissipative shock wave at the boundary between a plain Riemann wave and a stationary gaseous medium is proved theoretically in accordance with Eulerian hydrodynamics for the case of a "quadratic" singularity at the point of soft separation, the case of a "cubic" singularity at the reversal point having been considered in an earlier study. The wave function within the region of oscillations is described by the Korteweg-deVries equation and the latter, in the case of many oscillations, is solved by the Witham method. Existence and uniqueness of a "quasi-steady shock wave" solution is demonstrated upon collocation of solutions to the Euler equations and to the Whitham equations, even though the Witham system of differential equations is one of the second order while the number of independent boundary conditions is three at both leading and trailing edges of the wave. The leading edge is shown to be, as usually, a soliton. The authors thank A. P. Meshcherkin for making the numerical calculations. Figures 3; references 3: 2 Russian, 1 Western.

UDC 538.561

**Nonlinear Theory of Stimulated Raman Scattering of Electromagnetic Waves by Magnetized Relativistic Electron Beam**

18620057 Leningrad ZHURNAL TEKHNIЧЕСКОЙ ФИЗИКИ in Russian Vol 58 No 8, Aug 88 (manuscript received 8 May 87, in final version 29 Jun 87) pp 1457-1467

[Article by N. S. Ginzburg, A. S. Sergeyev, and M. D. Tokman, Institute of Applied Physics, USSR Academy of Sciences, Gorkiy]

[Abstract] A system of equations is derived describing the nonlinear stage of stimulated Raman scattering of electromagnetic waves by a relativistic electron beam in a uniform magnetic field with attendant emission of short-wave radiation observed in experiments with a helical relativistic electron beam. The process is considered from the quantum standpoint, taking into account two-photon interaction which transfers an electron to either a lower Landau energy level (normal Doppler effect) or a higher one (anomalous Doppler effect) while it scatters a high-frequency signal wave upon absorption of a low-frequency pump wave. The equations of electron ballistics are averaged and, assuming an infinitely wide electron beam, supplemented with equations of wave excitation after these have been averaged into equations for slowly varying amplitudes and so that the entire system satisfies the laws of energy and longitudinal momentum conservation. While during stimulated scattering one wave becomes stronger and the other becomes weaker under conditions of difference-frequency synchronism, both become stronger or weaker under conditions of sum-frequency synchronism. On the basis of this theory and analogy with a cyclotron-resonance maser is considered stimulated Raman scattering by a helical relativistic electron beam with an attendant normal Doppler effect and by a rectilinear one with an attendant anomalous Doppler effect. The amplitudes of both pump and signal waves as well as the electronic efficiency have been calculated, as functions of time, by the method of numerical simulation. Figures 5; references 16: 14 Russian, 2 Western.

**Experimental Detection of Stimulated Raman Scattering of Surface Electromagnetic Waves**

18620017a Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY ФИЗИКИ in Russian Vol 48 No 1, 10 Jul 88 (manuscript received 17 May 88) pp 16-18

[Article by A. N. Sudrakin and K. N. Ushakov, Institute of Problems in Mechanics, USSR Academy of Sciences]

[Abstract] An experiment with surface electromagnetic waves was performed, its purpose being detection and study of their stimulated Raman scattering. A signal wave was excited on the interface of a silver film and a

benzene layer. Another wave was excited through a right-angle prism made of glass (refractive index 1.775) by imperfect total internal reflection of radiation from a Nd-laser (wavelength 1060 nm). The signal wave was partly transformed into a volume wave (1185 nm). The results of measurements confirm the results of theoretical analysis with regard to stimulated Raman scattering of surface electromagnetic waves into volume electromagnetic waves, namely existence of a distinct threshold for this process in terms of laser wave intensity and a linear dependence of the volume wave intensity on the laser wave intensity above that threshold. The threshold was found to depend nonmonotonically on the angle of laser wave incidence, dipping to a minimum along with the linear reflection coefficient for its wavelength and this minimum corresponding to an incidence angle of 58.75 deg. figures 2; references 4; Russian.

UDC 621.315.592

**New Magneto-optic Transitions in Conduction Band of InSb at Temperatures Above 77 K**

18620031a Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 7, Jul 88 (manuscript received 1 Sep 87, in final version 25 Nov 87) pp 1952-1959

[Article by Ye. M. Sheregiy and O. M. Leshko, Drogobych Pedagogical Institute imeni I. Franko, Drogobych]

[Abstract] An experimental study of n-InSb at temperatures above 77 K was made, its purpose being to detect new magneto-optic transitions and to relate the shifting of their resonances upon a rise of temperatures with the temperature dependence of the conduction band parameters. Five specimens of this material were tested, their electron concentration and electron mobility of 77 K covering the  $(0.85-4.0) \cdot 10^{14} \text{ cm}^{-3}$  range and the  $(3.5-5.7) \cdot 10^5 \text{ cm}^2/(\text{V}\cdot\text{s})$  range respectively. A bar specimen, 6 mm long and  $2 \times 2 \text{ mm}^2$  in cross-section, was placed inside a 35 mm long solenoid 10 mm in diameter producing a magnetic field in pulses of 4 ms duration. It was excited once with 9570 nm radiation and once with 10,620 nm radiation from an ILGN-765 CO<sub>2</sub>-laser. The magnetic field was built up to 400 kOe and then dropped to 0, the second derivative of the field-dependent photovoltage with respect to the field intensity being plotted along both ascending and descending branches of the field cycle (after differentiation of the photovoltage) at temperatures from 77 K to 300 K. The photoconductivity measurements were made by a special method suitable for high temperatures in strong pulsed magnetic fields. The results revealed harmonics of the known cyclotron resonance and two phonon-cyclotron resonances, one with emission and one with absorption of a longitudinal optical phonon, also a two-phonon phonon-cyclotron resonance with phonon absorption. The authors thank I. B. Levinson for discussion of the experimental results and for valuable suggestions concerning their interpretation. Figures 5; tables 3; references 22: 8 Russian, 14 Western.

**Electron Pairing in Superconductors**

18620135b Moscow *TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian*  
Vol 78 No 2, Feb 89 (manuscript received 1 Oct 87)  
pp 314-319

[Article by Nguyen An Viet, Nguyen Van Hieu, Nguyen Toan Thang and Ha Vin Tan, Vietnam National Scientific Research Center; Vietnamese Institute of Theoretical Physics]

[Abstract] The N. N. Bogolyubov self-consistent field method, which provided an adequate mathematical basis for the investigation of physical processes in superconductors, is applied in a study of superconducting pairing of electrons in an isotropic electron fluid with a spin-dependent electron-electron interaction of a general form. It is shown that in an appropriate approximation the ground state (vacuum) of the superconducting electron fluid is a condensate of Cooper pairs of two species with two different energy gaps; the pairing of electrons with the same helicity occurs. After examining the pertinent effective Hamiltonian, a system of equations is derived for determining these two energy gaps in the spectrum of quasiparticle excitations. References 21: 12 Russian, 9 Western.

**Raman Light Scattering in Superconducting Crystals Based on Bi-Sr-Ca-Cu-O**

18620133e Moscow *PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian* Vol 49 No 3, 10 Feb 89 (manuscript received 20 Dec 88) pp 150-151

[Article by I. V. Aleksandrov, A. B. Bykov, A. F. Goncharov, V. N. Denisov, B. N. Mavrin, O. K. Melnikov, V. B. Podobedov, and N. I. Romanova, Spectroscopy Institute, USSR Academy of Sciences]

[Abstract] The polarization spectra of Raman light scattering (RLS) of monocrystals of the Bi-Sr-Ca-Cu-O system were investigated. In contrast to most earlier studies, it was possible to measure the RLS spectra from both the basal and lateral crystal planes, which made it possible to study RLS in zz-polarization and to identify the observed bands. Crystals of three different compositions were investigated. The crystal samples were plates measuring 2 x 1 x 0.005 mm with a c axis perpendicular to the plane. The RLS were excited by the line 514.5 nm of an argon laser and were analyzed using a triple multichannel spectrometer in the region 20-800 cm<sup>-1</sup>. The findings for each crystal composition are given. A preliminary identification of the bands is given. The strongest bands 965, 460, 634-655 cm<sup>-1</sup> are attributable to Bi-O oscillations. Figure 1; references 10: 4 Russian, 6 Western.

**Propagation of Surface Acoustic Wave in Layered Structure. YBaCuO- LiNbO<sub>3</sub> Superconducting Film**

18620124b Leningrad *PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian*  
Vol 15 No 1, 12 Jan 89 (manuscript received 17 Nov 88)  
pp 11-15

[Article by Ye. V. Balashova, V. V. Lemanov, F. A. Chudnovskiy, E. M. Sher, A. B. Sherman, L. M. Emiryman, and A. N. Yanuta, Physical Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] Surface acoustic waves were used in studying the acoustic properties of high-temperature superconducting YBaCuO films. Data were obtained making possible a comparison of the acoustic properties of the high-temperature superconducting film and ceramic and registry of information on the most characteristic behavior of these properties. The films were produced by the laser deposition method with subsequent annealing in an oxygen atmosphere. The mean film thickness was 7 μm. According to the results of an X-ray structural analysis and electron microscope analysis the films had a hypocrySTALLINE structure with a mean grain size 3 μm. The backings used were lithium niobate plates. The attenuation of the surface acoustic waves in the investigated YBaCuO-LiNbO<sub>3</sub> structure was measured, as well as the dependence of attenuation and phase velocity of surface acoustic waves on temperature and frequency. The dispersion of the phase velocity of these waves was also investigated. The research results are represented graphically and analyzed in the text. Figures 2; references 9: 3 Russian, 6 Western.

**Thin-Walled Niobium Cylinder as Superconducting Quantum Magnetometer**

18620124c Leningrad *PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian*  
Vol 15 No 1, 12 Jan 89 (manuscript received 24 Oct 88)  
pp 41-44

[Article by V. M. Zakosarenko, Ye. V. Ilichev, and V. A. Tulin]

[Abstract] J. M. Goodkind, et al. (Dundon Rev. Sci. Inst., Vol 42, p 1264, 1971) reported that niobium cylinders, after anodizing, can be used in measuring magnetic fluxes. A response to change in the magnetic field was observed, but no explanation was given, motivating further research. Niobium with a thickness 800-1000 Å was sprayed on the lateral surface of a rotating quartz cylinder. Samples 5-15 mm were placed in a coupling coil which was connected into a circuit with a resonance frequency 25-30 MHz. The HF volt-ampere characteristic and signal characteristics of the resonance circuit with the sample were registered. The measurement scheme was described in detail by the authors in an earlier article (PISMA V ZhTF, Vol 13, p 1389, 1987). All measurements were made in liquid helium at 4.2 K.



An explanation was sought for the observed nonlinearities of the volt-ampere characteristic. It was found that magnetic field penetration into the cylinder was associated with movement of magnetic flux eddies perpendicular to the film. When the end of the cylinder was in the coil magnetic field distortions arose near the edge of the film, giving rise to motion of eddies in the film. As a result, under certain conditions the other end of the sample did not "operate." This could be rectified by making the niobium film more precise there by electrolytic anodizing of the niobium in a 1 percent solution of  $\text{NH}_4\text{Cl}$ . Oscillations from both ends could then be observed when placing the sample in a coupling coil whose length was greater than the length of the sample. Figures 2; references 4: 3 Russian, 1 Western.

UDC 537.312.62

**Mechanism of High-Temperature Superconductivity in  $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$**

18620121a Leningrad FIZIKA TVERDOGO TELA in Russian Vol 31 No 1, Jan 89 (manuscript received 16 Mar 88, after revision 21 Jun 88) pp 46-56

[Article by E. A. Pashitskiy, Physics Institute, Ukrainian Academy of Sciences, Kiev]

[Abstract] One of the possible reasons for high-temperature superconductivity in compounds with a structure of the  $\text{YBa}_2\text{Cu}_3\text{O}_7$  type is the quasi-one-dimensionality of the electron spectrum in linear Cu-O chains and the associated anisotropy of the spectrum of slightly attenuating collective excitations of charge density, low-frequency quasi-one-dimensional plasmons. The "plasmon" mechanism (which is described in detail) for the intensification of interelectron attraction in 1D-chains due to exchange of virtual LF plasmons with an anisotropic quasi-acoustic spectrum makes it possible to understand the reason for high-temperature superconductivity of the mentioned type of compounds and many properties of these superconductors unusual at first glance: anomalously low isotopic effect, gapless character of superconductivity, greatly attenuating LF excitations in the optical spectra,  $T_c$  decrease with a decrease in oxygen content, slight  $T_c$  sensitivity relative to replacement of Y by any rare earth element and sharp  $T_c$  decrease with the replacement of Cu by other metals, both magnetic and nonmagnetic. Figure 1; references 53: 22 Russian, 31 Western.

UDC 537.312.62

**Order Parameter Localization and High-Temperature Superconductivity**

18620121b Leningrad FIZIKA TVERDOGO TELA in Russian Vol 31 No 1, Jan 89 (manuscript received 6 Jul 88) pp 278-280

[Article by I. M. Suslov, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] The dependence of the maximal attainable  $T_c$  on time indisputably indicates that in superconductors of the  $\text{La}_2\text{CuO}_4$  class (see: J. R. Ashburn, et al., PHYS.

REV. LETT., Vol 58 No 8, p 908, 1987) some new, earlier unimportant factor begins to play a significant role. In this article, within the framework of a traditional scheme, it is shown that the spatial nonuniformity of the electron-phonon interaction  $\lambda$  may be such a new factor. The rationale for this conclusion is illustrated in a specific example. Figures 2; references 8: 4 Russian, 4 Western.

UDC 535.33/.34:538.915

**X-ray Spectral Research on Electron States of  $\text{YBa}_2\text{Cu}_3\text{O}_7$**

18620121c Leningrad FIZIKA TVERDOGO TELA in Russian Vol 31 No 1, Jan 89 (manuscript received 27 Jul 88) pp 312-314

[Article by A. Mayste and R. Ruus, Physics Institute, Estonian Academy of Sciences, Tartu]

[Abstract] In the  $\text{YBa}_2\text{Cu}_3\text{O}_7$  system the bands of free and occupied states have a complex structure in whose formation the main role is played by O(2p)- and Cu(3d)-states, which are strongly hybridized. An unanswered question is how the subzones of these states are situated relative to one another and relative to the Fermi level. Some authors have suggested that in the valence band O(2p)-like states lie closer to  $E_F$  than the Cu(3d) state, whereas others are in variance from this conclusion. A study was made of X-ray emission and absorption spectra in order to clarify this matter. Cu( $L_{2,3}$ ), Ba( $M_{4,5}$ ) and O(K) spectra were measured in  $\text{YBa}_2\text{Cu}_3\text{O}_7$  studied earlier by optical methods. The spectra were obtained at room temperature in a vacuum. The emission was excited by an electron beam; the absorption spectra were obtained by measurement of the pulsed quantum yield of the total photoemission. A series of conclusions were drawn on the basis of this research, among them the following. The energies  $E_F$  of the studied system relative to the Cu( $L_3$ ) and O(K) levels are approximately 930 and 528 eV. For Cu this is 2-3 eV less than obtained in other measurements. Free states of both the O(2p) and Cu(3d) types are situated directly near the Fermi level, which is consistent with other computations and measurements. The subzones of the occupied states of the O(2p) and Cu(3d) types are superposed on one another with their maxima lying about 2.5 and 1 eV below the Fermi level respectively. The 3d-subzone lies closer to the Fermi level than the 2p-subzone. Figure 1; references 17: 4 Russian, 13 Western.

**High-Frequency Surface Resistance of Granulated Superconductor Beyond Percolation Threshold**

18620120d Leningrad ZHURNAL TEKHNIЧЕСКОЙ FIZIKI in Russian Vol 59 No 1, Jan 89 (manuscript received 29 Dec 87) pp 107-112

[Article by O. G. Vendik, A. B. Kozyrev, and A. Yu. Popov, Leningrad Electrical Engineering Institute imeni V. I. Ulyanov (Lenin)]

[Abstract] Theoretical and experimental research on granulated superconductors with a high temperature transition is continued. The principal model in the

theoretical estimates is a system of superconducting granules connected by weak bonds having the properties of a Josephson transition. The article examines the surface resistance of a granulated superconductor relative to an external electromagnetic wave. The surface resistance of a regular cubic structure of granules is examined in detail. The computed relations are compared with experimental measurements of the surface resistance of the ceramic Y-Ba-Cu-O. This comparison made it possible to draw conclusions on the properties of intergranular contacts. It was found that on the basis of measurements of the dependence of  $R_{\text{surf}}$  on temperature and frequency in the high frequency and microwave ranges it is possible to ascertain the averaged structural parameters:  $a$ ,  $R_N(T)$ ,  $I_c(T)$ ,  $V_c(T)$ . Although the derived relations have a model character, they may be useful for a quantitative comparison of investigated samples and the methods for their preparation. Figures 5; references 15: 9 Russian, 6 Western.

UDC 537.311.62

#### **New Type of High-Temperature Superconductor Absorption of Microwaves in Weak Magnetic Field**

18620075 Moscow DOKLADY AKADEMII NAUK  
SSSR in Russian Vol 303 No 1, Nov 88 (manuscript  
received 13 Sep 88) pp 94-96

[Article by B. V. Rozentuller, S. V. Stepanov, M. M. Shabarchina, and A. I. Tsapin, Institute of Chemical Physics, USSR Academy of Sciences, Moscow]

[Abstract] A highly sensitive contactless method, EPR-spectroscopy based on absorption of microwaves and utilizing the dependence of the absorption level on the direction of the scanning magnetic field inside the spectrometer cavity, was successfully used for identification of new high-temperature superconducting phases. Two effects characteristic of superconductors only served as the criteria, namely appearance of a strong narrow "signal" in a weak magnetic field ( $\sim 40$  to  $40$  G) and steep rise of the noise level (by 2-3 orders of magnitude) with the temperature dropping below the critical. The scanning magnetic field of the spectrometer was weakened to sufficiently low levels by means of Helmholtz coils producing an antiparallel constant magnetic field of  $400$  G. The method was applied to Mo-V materials, powder specimens having been produced by mixing and then vaporizing aqueous solutions of  $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}\cdot 4\text{H}_2\text{O}$  and  $\text{NH}_4\text{VO}_3$  with the pH varied over the 2-11 range. The specimens were heat treated at  $100^\circ\text{C}$  for  $1$  h. Subsequent measurements revealed a dependence of the EPR critical temperature on the vanadium content in the salt mixture, the critical temperature peaking to  $112$  K for 82 pct V and not dropping below  $90$  K for 71-88 pct V. They also yielded the temperature dependence of the "signal" current times temperature product, characterized by a monotonic steep increase of this IT-product with the temperature dropping below the critical. The

search for superconducting phase was extended by addition of Bi, Ba, Sr, Cu, Fe nitrates to the optimum Mo-V salt mixtures, also by complete replacement of  $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}\cdot 4\text{H}_2\text{O}$  with  $(\text{NH}_4)_6\text{W}_7\text{O}_{24}\cdot 6\text{H}_2\text{O}$ . Quantitative determination of superconducting phases by EPR-spectroscopy requires use of a calibrating reference specimen whose phase composition is known on the basis of standard measurements. The authors thank Yu. A. Buslayev for discussion of the results. Article was presented by Academician Yu. A. Buslayev on 15 August 1988. Figures 2; references 4: 1 Russian, 3 Western.

UDC 537.533.7

#### **Computations of Highly Precise Electron Beams and Their Transport**

18620108a Leningrad ZHURNAL TEKHNIЧЕСКОY  
FIZIKI in Russian Vol 58 No 11, Nov 88 (manuscript  
received 13 Jul 87, after revision 17 Jun 88)  
pp 2168-2173

[Article by V. T. Astrelin and P. Vrba, Plasma Physics Institute, Czechoslovakian Academy of Sciences, Prague]

[Abstract] Electron beams for heating plasma, formed in the "REBEX" magnetic system, are used at the Czechoslovakian Plasma Physics Institute. Computations of the formation of a highly precise electron beam in diodes with cathodes of different configuration in an external magnetic field are given. It is shown that the configuration of the cathode exerts a substantial influence on the distribution of the current over the surface of the plate: for a concave cathode the beam is close to tubular, but in the case of a conical cathode is virtually uniform. Problems in the transport of a beam in a vacuum and in plasma-filled drift space are examined. In the absence of plasma the beam current is restricted to the limiting vacuum value. The influence of the external magnetic field makes it possible to increase the beam current during transport in plasma in comparison with the limiting Alfvén value. The "POISSON-2" specific program package makes it possible to solve stationary problems in the formation of beams in the absence of a virtual cathode. Figures 13; references 6: 3 Russian, 3 Western.

#### **Dependence of Raman Light-Scattering Spectra of $\text{YBa}_2\text{Cu}_3\text{O}_x$ Compounds on Oxygen Content**

18620071b Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 48 No 7, 10 Oct 88 (manuscript  
received 30 Aug 88) pp 380-383

[Article by Yu. S. Ponomarev, G. A. Bolotin, O. V. Gurin, N. M. Chebotayev, A. A. Samokhvalov, and S. V. Naumov, Institute of Metal Physics, Ural Department, USSR Academy of Sciences]

[Abstract] An experimental study of Raman scattering of polarized light in orthorhombic and tetragonal  $\text{YBa}_2\text{Cu}_3\text{O}_x$  single crystals, also in polycrystalline



YBa<sub>2</sub>Cu<sub>3</sub>O<sub>x</sub> ceramic, was made with the oxygen content  $x$  varied over the 6.05-6.94 range. Orthorhombic crystals having a critical superconducting transition temperature within the 70-60 K range were grown in the form of 0.03 mm thick and 1 mm square plates with a 1.1705 nm lattice  $c$ -parameter. Tetragonal crystals with a 1.180 nm lattice  $c$ -parameter were obtained by annealing under vacuum. All lines in the Raman spectra of these single crystals corresponded to A<sub>1g</sub> or B<sub>1g</sub> vibrations in the tetragonal phase and to A<sub>g</sub> vibrations in the orthorhombic phase. The varying asymmetry of excitations within the phononic range of the Raman spectra indicates a dependence of both anisotropic 115 cm<sup>-1</sup> and 495 cm<sup>-1</sup> lines on the oxygen content in the Cu(1)-O(4) chains, also an association of these lines with Ba and O(1) modes. The isotropy of both 147 cm<sup>-1</sup> and 339 cm<sup>-1</sup> lines confirms their association with vibrations of atoms in the more remote CuO<sub>2</sub> layers. Scattering by electrons was found to cover a wide range of the Raman spectra, up to 5000 cm<sup>-1</sup>, with a sharp peak at 2600 cm<sup>-1</sup> for the tetragonal phase and a soft peak covering lower frequencies for the orthorhombic phase. Figures 2; references 11: 6 Russian, 5 Western.

#### Effect of Mg Impurity of Superconductivity of Bi-Sr-Ca-Cu Metal Oxides

18620071c Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 48 No 7, 10 Oct 88 (manuscript  
received 2 Aug 88) pp 384-386

[Article by Ye. M. Gololobov, N. A. Prytkova, Zh. M. Tomilo, D. M. Turtsevich, and N. M. Shimanskaya, Institute of Solid-State and Semiconductor Physics, BSSR Academy of Sciences]

[Abstract] An experimental study of high-temperature superconductor materials Bi<sub>2</sub>Sr<sub>2</sub>CaMg<sub>x</sub>Cu<sub>2</sub>O<sub>y</sub>, BiSrCaMg<sub>x</sub>Cu<sub>2</sub>O<sub>y</sub>, Bi<sub>2</sub>Sr<sub>2</sub>Ca<sub>1-x</sub>Mg<sub>x</sub>Cu<sub>2</sub>O<sub>y</sub> with  $x$  ranging from 0 to 1 was made, for the purpose of determining the effect of Mg impurity on their characteristics. Specimens for this study were synthesized from fine-disperse dry Bi<sub>2</sub>O<sub>3</sub>, MgO, CuO, SrCO<sub>3</sub>, CaCO<sub>3</sub> powders by solid-phase reaction at a temperature within the 800-870 deg C range in air. Phase analysis was done in a DRON-3 x-ray diffractometer. The electrical resistance was measured over the 300-4.2 K temperature range, by the voltage-current method with a direct current of 0.5-2.0 mA. On the basis of these measurements was determined the dependence of the temperature range of superconducting transition on the Mg content. The results indicate that the temperature at which superconducting transition begins and the temperature at which it is completed do not change upon addition of Mg up to Mg<sub>0.3</sub>, drop slightly upon further addition of Mg up to Mg<sub>1.0</sub>, but drop appreciably upon replacement of Ca with Mg: down to 10 K and below 4.2 K respectively for Bi<sub>2</sub>Sr<sub>2</sub>MgCu<sub>2</sub>O<sub>y</sub>. In the latter case there evidently forms at least one additional phase whose fraction increases with increasing Mg content (and decreasing Ca content),

while both Bi<sub>2</sub>Sr<sub>2</sub>CaCu<sub>2</sub>O<sub>y</sub> and BiSrCaCu<sub>2</sub>O<sub>y</sub> evidently contain a small fraction of a phase whose superconducting transition begins at 117 K. Figures 3; references 5: 1 Russian, 4 Western.

#### Effect of Anderson Impurities With Strong Local Electron-Phonon Interaction of Critical Superconducting Transition Temperature

18620071d Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 48 No 7, 10 Oct 88 (manuscript  
received 9 Aug 88) pp 389-391

[Article by A. G. Malshukov, Institute of Spectroscopy, USSR Academy of Sciences]

[Abstract] The effect of an Anderson impurity with strong local electron-phonon interaction is analyzed theoretically in accordance with the Anderson model and on the basis of the impurity Hamiltonian, for the simplest case with only one vibrational degree of freedom. The quasi-steady impurity level is assumed to be nondegenerate and much wider than the oscillator frequency at zero penetration depth, the oscillator becoming unstable in the adiabatic approximation when the coherence length exceeds the critical and a two-well adiabatic term appears after the quadratic term in potential energy has vanished. Calculations aided by numerical simulation, with Coulomb repulsion and attraction of electrons taken into account, have yielded the derivative of critical temperature with respect to impurity concentration for two cases corresponding to temperatures much lower than the Kondo temperature and thus to a Fermi liquid: coherence length much smaller than the critical with no localized spin on the impurity and coherence length larger than twice the critical. The isotope effect is determined from the dependence of the Kondo temperature on the oscillator frequency at zero penetration depth and found to be absent if the Tcvelick-Wiegmann relation for the Kondo temperature is valid. The author thanks V. M. Agranovich and V. Ye. Kravtsov for discussion. References 13: 2 Russian, 11 Western.

#### Anisotropy of Superconducting Transition Temperature for Bi-Sr-Ca-Cu-O Single Crystal

18620071e Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 48 No 7, 10 Oct 88 (manuscript  
received 23 Aug 88) pp 399-400

[Article by V. L. Arbuzov, O. M. Bakunin, A. E. Davletshin, S. M. Klotsman, M. B. Kosmyna, A. B. Levin, and V. P. Seminozhenko, Institute of Metal Physics, Ural Department, USSR Academy of Sciences]

[Abstract] An experimental study of a Bi<sub>2</sub>Sr<sub>3-x</sub>Ca<sub>x</sub>Cu<sub>2</sub>O<sub>8</sub> +  $\epsilon$  single crystal was made involving measurement of its magnetic susceptibility and electrical resistance in directions parallel and perpendicular to its  $c$ -axis at temperatures from 85 K to 4.2 K. The crystal was grown from a molten solution in CuO, by cooling from the 1270-1070

K crystallization range at a rate of 5 K/h and subsequent annealing at 1150 K for 30 h in air. The magnetic susceptibility was measured in an alternating magnetic field of 8 A/m intensity at a frequency of 77.7 kHz. Measurements in such a longitudinal magnetic field yielded a 27 K wide temperature range of superconducting transition and a critical temperature within 77-71 K, while measurements in such a transverse magnetic field yielded a 15 K wide temperature range and a critical temperature within 31-21 K. The electrical resistance was measured by the voltage-current method with a direct current. Measurements with a longitudinal current yielded a wide temperature range of superconducting transition, from 26 K to below 4.2 K, and a critical temperature of approximately 16 K, while measurements with a transverse current yielded a 26 K wide temperature range and a critical temperature within 79-73 K. The author thanks S. V. Vonsovskiy for interest and attentiveness. Figures 2; references 3: Western.

UDC 537.312.62

#### High-Temperature Superconductivity of Metallic Oxides Based on Bi-Sr-Ca-Cu Alloyed With Magnesium

18620111c Minsk VESTSI AKADEMII NAVUK BSSR: SERIYA FIZIKA- MATEMATYCHNYKH NAVUK in Russian No 5, Sep-Oct 88 (manuscript received 4 May 87) pp 38-41

[Article by Ye. M. Gololobov, N. A. Prytkova, Zh. M. Tomilo, D. M. Turtsevich, and N. M. Shimanskaya, Institute of Solid State Physics and Semiconductors, Belorussian SSR]

[Abstract] Bismuth ceramics of different composition obtained in different regimes revealed the presence of two superconducting phases: low- and high-temperature. The Cu content exerts a significant role in their superconducting properties. This article reports on synthesis and investigations of the superconducting properties of a high-temperature superconducting metallic oxide based on Bi-Sr-Ca-Cu-O with the addition of magnesium. Two six-component systems were investigated:  $\text{BiMg}_x\text{SrCaCu}_2\text{O}_y$  and  $\text{Bi}_2\text{Mg}_x\text{Sr}_2\text{CaCu}_2\text{O}_y$ . The samples were synthesized in air at 800-870°C. The corresponding mixtures were prepared using dried oxides  $\text{Bi}_2\text{O}_3$ ,  $\text{MgO}$ ,  $\text{CuO}$  and carbonates  $\text{SrCO}_3$ ,  $\text{CaCO}_3$ . The Meissner effect was observed in all samples. A table gives the superconducting parameters of the investigated samples. It is postulated that the structure of the high-temperature Bi-Sr-Ca-Cu-O superconducting phase belongs to a system with low symmetry, but it has not yet been possible to determine it in detail. The bismuth superconducting ceramic was more sensitive to annealing temperature than an yttrium superconducting ceramic. Data are given on its resistivity in the temperature range 4-300 K. Figures 2; references: 7 Western.

UDC 538.945

#### Experimental Developments in High-Temperature Superconductors

18620058 Moscow USPEKHI FIZICHESKIKH NAUK in Russian Vol 156 No 1, Sep 88 pp 117-135

[Article by L. P. Gorkov and N. B. Kopnin, Institute of Theoretical Physics imeni L. D. Landau, USSR Academy of Sciences, Chernogolovka (Moscow Oblast)]

[Abstract] Available experimental data on high-temperature superconductors are reviewed and interpreted, there being three fundamental items of concern: 1) width of the range of fluctuations about the critical temperature, 2) effect of anisotropy of other properties on the superconductivity characteristics, 3) validity of describing both normal and superconducting states in terms of a Fermi fluid without reference to a specific pairing mechanism and thus assuming a wide electron delocalization band above the critical temperature, or describing them in terms of a strongly correlated electron system such as the one in the Anderson model of resonating valence bonds. Experimental data on  $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$  and  $\text{YBa}_2\text{Cu}_3\text{O}_{7-d}$ , single crystals and ceramics, are evaluated from this standpoint. The data include specific heat, electrical resistivity, paramagnetic susceptibility, and both critical magnetic field intensities measured above the critical temperature, also the Hall effect and estimates of the Pauli spin susceptibility. The data covering the vicinity of the critical temperature are analyzed on the basis of the phenomenological Ginzburg-Landau theory, but parameters in the microscopic Bardeen-Cooper-Schrieffer theory are also estimated. Dependence of the superconductivity characteristics on the material composition, impurity (Sr) level  $x$  or oxygen deficiency  $d$ , is discussed in terms of the Anderson model, this model adequately describing the "spin glass" state and the "spin fluid" state but not fitting the data on the composition dependence of the low-temperature specific heat and of its jump at the superconducting transition point. The authors thank V. P. Mineyev for his valuable comment. Tables 6; references 97: 6 Russian, 91 Western (1 in Russian translation, 1 private communication).

#### Production of Thin Y-Ba-Cu-O Layers by Laser Annealing

18620069b Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 14 No 17, 12 Sep 88 (manuscript received 21 Dec 87, in final version 28 May 88) pp 1588-1590

[Article by A. V. Verbilo, G. M. Gusakov, A. A. Komarnitskiy, V. Z. Petrova, and L. S. Sukhanova, Moscow Institute of Electronics Engineering]

[Abstract] Less than 0.001 mm thick layers of  $\text{YBa}_2\text{Cu}_3\text{O}_7$  with a less than 3 K wide range of the critical superconducting transition temperature within 96-102 K were produced by laser annealing the surface of

compacts of fine-disperse  $Y_2O_3$ , BaO, CuO mixtures, these mixtures having been prepared for this by dissolving  $Y_2(NO_3)_3$ ,  $Ba(NO_3)_2$ ,  $Cu(NO_3)_2$  in  $HNO_3$  with the proper Y:Ba:Cu stoichiometry and vaporizing the solution. The sediment was annealed at about 900 deg C in air for several hours. Subsequent surface annealing of 1 mm thick compacts was done with a Nd-laser in an oxygen atmosphere, a pressure of 100 atm ensuring the correct stoichiometry. The laser beam 0.200 mm in diameter to the 1/e intensity level scanned the surface line-by-line in 0.050 mm steps in pulses of 50 ns duration, the energy density being varied over the 0.01-1.00 J/cm<sup>2</sup> range. The superconducting transition of the surface layer after this treatment was recorded to begin at 98 K and even at 102 K in some cases, on the basis of magnetic susceptibility measurements over the 300-4.2 K temperature range in an alternating magnetic field of 30 Oe amplitude and 41 Hz frequency. The temperature was recorded with a TSV-1 resistance thermometer accurately within 0.5 K, superconducting transition of Sn being responsible for the jump of magnetic susceptibility at 7.2 K. The critical current density at 77 K without a magnetic field was at least  $(5-8) \cdot 10^5$  A/cm<sup>2</sup>. The authors thank S. V. Gaponov for helpful discussion of the results. Figures 1; references 3: 1 Russian, 2 Western.

**Initiation of Impact Breakdown in Vacuum Diodes With Electrodes Made of High-Temperature Superconductor Materials**

18620056b Leningrad PISMA V ZHURNAL  
TEKHNICHESKOY FIZIKI in Russian  
Vol 14 No 16, 26 Aug 88 (manuscript received  
31 May 88) pp 1441-1444

[Article by V. G. Mesyats and S. I. Shkuratov, Institute of Electrophysics, USSR Academy of Sciences, Sverdlovsk]

[Abstract] An experimental study of  $YBa_2Cu_3O_{7-d}$  ceramic and single crystals as cathode material was made, for the purpose of determining their electric impact strength. A diode was built in the form of a vacuum chamber with the wall made of stainless steel and the residual pressure not exceeding  $10^{-7}$  Pa. The ceramic cathodes were conical with the tip rounded to a 0.050-0.100 mm radius. The single-crystal cathodes were 3 mm long bars with 0.02 mm square cross-section. The anode was a disk 5 mm in diameter of the same material. They were tested at temperatures of 300-150-78-4.2 K, the diode being placed in a Dewar flask with nitrogen or helium for cooling to low temperatures. High-voltage

pulses of up to 50 kV amplitude and 10-1300 ns duration with a 2 ns rise time were applied from a square-wave generator. The time lag from arrival of a voltage pulse to breakdown, inversely proportional to the electric field intensity at the cathode surface, was measured and found to increase with decreasing temperature and the breakdown current to increase correspondingly. The electric strength of these cathodes was found to be lower than that of Nb and W cathodes, evidently owing to the higher electrical resistivity and lower thermal conductivity of the superconductor material. This deficiency was subsequently overcome by conditioning the cathode material with a dielectric "crust", formed by arc discharges under vacuum and attenuating the electric field underneath. The authors thank G. A. Mesyats and V. F. Puchkarev for support, helpful comments, and discussion of the results. Figures 2; references 2: Russian.

**Field-Ion Microscopy of  $YBa_2Cu_3O_{7-d}$  Superconductor**

18620056c Leningrad PISMA V ZHURNAL  
TEKHNICHESKOY FIZIKI in Russian  
Vol 14 No 16, 26 Aug 88 (manuscript received  
24 May 88) pp 1504-1507

[Article by G. A. Mesyats, N. N. Syutkin, V. A. Ivchenko, and Ye. F. Talantsev, Institute of Electrophysics, Ural Department, USSR Academy of Sciences]

[Abstract] Surface examination of  $YBa_2Cu_3O_{7-d}$  superconductor specimens under a field-ion microscope has yielded an image of the superconductor surface with atomic-scale resolution, revealing a predominance of Y atoms at the surface when the latter is pure. Specimens of this material had been produced in the form of 10 mm long bars with 1 mm square cross-section, these specimens having been ground with a diamond wheel and then electrochemically etched with HCl solution in monobutyl ester of ethylene glycol. Atomic-scale surface smoothness was attained by field evaporation of asperities on the hemispherical specimen-emitter surface under vacuum in the microscope. Cooling to 63 K was done with solid nitrogen. Gaseous molecular nitrogen with an admixture of other gases was used as imaging medium and microchannel converter was used as image intensifier. On the image were seen not only regular concentric rings produced by yttrium surface atoms but also randomly spaced bright dots probably representing atoms of another element underneath. The authors thank A. N. Petrov, A. Yu. Zuyev and S. I. Shkuratov for supplying the specimens. figures 2; references 2: 1 Russian, 1 Western.

UDC 519.676

**Comparison of Some Procedures for Random Search for Global Extremum**

18620130a Moscow ZHURNAL VYCHISLITELNOY  
MATEMATIKI I MATEMATICHESKOY FIZIKI in  
Russian Vol 29 No 2, Feb 89 (manuscript received  
23 Oct 87, after revision 28 Jun 88) pp 163-170

[Article by S. M. Yermakov, A. A. Zhiglyavskiy, and M.  
V. Kondratovich, Leningrad]

[Abstract] A comparison of the quality of procedures for search for the extremum is difficult when a quite broad class of functions is considered. In random search procedures the theory of statistical solutions makes possible a comparison of such a type for very broad classes of functions. This article examines a relatively simple

example although the described approach is undoubtedly suitable for considerably more complex situations. The research was based on the concepts developed by S. M. Yermakov in a study entitled "Admissibility of Monte-Carlo Procedures" in DOKL. AN SSSR, Vol 172 No 2, pp 262-263, 1967. These concepts are naturally generalized for procedures for random search for a global maximum of the continuous function  $f$ , stipulated in the compact metric space  $X$ . The algorithms for random search for the global extremum of this function consist of a number of iterations, in each of which some distribution is modeled. The distribution of points in the next iteration is usually constructed by using one or more of the best (record) values of the objective function computed at points of the particular iteration. The "random search procedure" is an algorithm for obtaining  $N$  random (not mandatorily independent) points with a stipulated distribution and computing the record value (or several record values) of the  $f$  function. References: 5 jRussian.

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